New Technique of Applying Topical Oxygen Therapy as a Cost-Effective Procedure

Vivek Agarwal · Shashank Aroor · Nikhil Gupta ·
Arun Gupta · Nitin Agarwal · Navneet Kaur

Received: 17 July 2014 / Accepted: 5 January 2015 / Published online: 24 March 2015
© Association of Surgeons of India 2015

Abstract To describe the newly designed technique of applying topical oxygen therapy for large wounds. C arm sterile disposable cover is used for covering the wound. For abdominal and pelvis wounds, two artificial holes are created at one end of the cover for the inclusion of the limb. Free end of the cover is secured with adhesive, and a hole is created for the insertion of the suction catheter. Oxygen cylinder is connected to the suction catheter, and oxygen is supplied at the rate of 10 L/min. Three patients were treated with topical oxygen therapy. These patients were cases of necrotizing soft tissue infections and large post traumatic wounds. There were less requirements of debridement and granulation tissue appeared earlier. The cost of one cycle of the therapy is less than 500 INR. Topical oxygen therapy is the recent modality for improved wound healing. The novel method of applying topical oxygen devised by us is effective, feasible, and cost-effective as compared to standard devices.

Keywords Topical oxygen · Hyperbaric oxygen · Wound healing · Necrotizing soft tissue infection · Wound management · New technique

Introduction

Hyperbaric oxygen therapy has been used for the healing of diabetic ulcers, chronic wounds, and post traumatic

wounds [1]. As compared with hyperbaric oxygen therapy, several studies have been conducted in assessing the effectiveness of topical oxygen therapy [2, 3]. Even though topical oxygen therapy does not create high pressures, studies have shown that this modality is effective in promoting wound healing [4]. Devices which are in use for topical oxygen therapy create a pressure of 50 mb (millibars) and increases the local oxygen concentration [5]. We have devised a technique which can provide similar oxygen concentration and pressure to be used as topical oxygen therapy at a very low cost. This technique was tested as a pilot study at a tertiary care health center.

Novel Method of Applying Topical Therapy

Wound that is to be dressed is prepared by opening the dressing and removing the superficial slough. Sterile disposable cover is used for covering the wound. For abdominal and pelvis wounds, two artificial holes are created at one end of the cover for the inclusion of the limb. Free end of the cover is secured with adhesive, and a hole is created for the insertion of the suction catheter. Oxygen cylinder is connected to the suction catheter, and oxygen is supplied at the rate of 10 L/min. The pressure is measured by the help of CVP manometer which is connected to one more hole. The pressure can be built till 30 mbars. This therapy is kept for 90 min and regular dressing is done after the procedure. The same cycle is repeated everyday till the wound is granulating. The final setup will look as shown in Fig. 1a and b.

V. Agarwal · S. Aroor (✉) · N. Gupta · A. Gupta · N. Agarwal ·
N. Kaur
Department of Surgery, University College of Medical Sciences and
GTB Hospital, Dilshad Garden, Delhi 110095, India
e-mail: shashank_smg@yahoo.com

Fig. 1 **a** and **b** Topical oxygen therapy with inflated plastic. The Foleys catheter and suction for applying oxygen can be seen at the lower end of the inflated plastic

Outcomes

The outcomes of large NSTI wounds after topical oxygen therapy following debridement are shown in Fig. 2a and b.

Similarly, large post traumatic wound that was treated with oxygen therapy is shown in Fig. 3. There were fewer requirements of debridement, and wound was healthy for grafting within 1 week of topical oxygen therapy.

Discussion

Hyperbaric oxygen therapy (HBOT) has been used as a treatment modality for diabetic foot ulcers, compromised flaps, and large wounds. Pressures applied in the chamber are usually 2 to 3 atm absolute (ATA) (equivalent to 2000 to 3000 mbars), and patient breathes 100 % oxygen. Wound healing hyperbaric protocols involve daily treatments of 1.5 to 2 h for 20 to 40 days. Kessler et al. in their randomized control study on hyperbaric oxygen therapy to heal nonischemic diabetic foot ulcers concluded that this hyperbaric oxygen therapy helps in

wound healing by promoting neovascularisation, recruitment of stem cells, production of growth factors, and improved cell migration [1].

High cost of hyperbaric oxygen therapy, nonavailability of hyperbaric oxygen chambers in all hospitals, systemic adverse effects of hyperbaric oxygen has lead to the usage of topical oxygen therapy for wound healing. The comparison of HBOT with topical oxygen therapy is shown in Table 1.

Fries et al. studied the effect of topical oxygen in pigs. Fries et al. saw an increase of pO₂ from less than 10 to 40 mmHg in as little as 4 min after applying topical oxygen at 3–6 l/min with a plastic device. Finally, Fries et al. could demonstrate by histology that wounds treated with oxygen showed signs of improved angiogenesis and tissue oxygenation in pig [2].

Blackman et al. in their prospective study on diabetic foot ulcers compared healing rates of chronic diabetic foot ulcers treated with topical oxygen versus advanced moist wound therapy [3]. Topical wound oxygen devices were used. Topical wound oxygen device delivered humidified oxygen into an extremity chamber in a cyclical manner. The cycle consisted of pressurizing the chamber to 50 mb. Sixty-minute treatments were given 5 days per

Fig. 2 **a** and **b** NSTI wound over abdomen and lower limb of different patients after debridement and topical oxygen therapy

Fig. 3 **a** and **b** Posttraumatic wound over the abdomen and comparison after 1 week of topical oxygen therapy. The significant decrease in slough with granulation after topical oxygen therapy can be seen in the picture

week. They found that the proportion of diabetic foot ulcer with complete healing was significantly greater in the topical wound oxygen patients than advanced moist wound therapy patients. They concluded that topical oxygen therapy is a simple noninvasive procedure without any adverse effects which can promote wound healing.

Similarly, Tawfick et al. in their study on comparison between convention compression dressings and topical oxygen on refractory venous ulcers found topical oxygen therapy to be beneficial in terms of shorter healing time and improving the quality of life [4]. They used topical oxygen device for 180 min twice daily under 50 mb pressure. Oxygen was supplied at 10 l/min.

The cost of topical oxygen therapy in comparison with hyperbaric oxygen therapy has been studied by many authors. Patricia Banks in their case reports on pressure ulcer healing with the help of topical oxygen in patients of spinal cord injury concluded that the cost of topical oxygen therapy using topical oxygen device (Epiflo) is about 42,000 INR weekly in comparison to cost of hyperbaric oxygen therapy which would range from 450,000 to 5,000,000 INR weekly depending on number of sessions [5].

Table 1 Comparison of topical oxygen with hyperbaric oxygen therapy

	Hyperbaric oxygen	Topical oxygen
1. Setup	Oxygen chambers	Local devices
2. Pressure	3000 mb	30–50 mb
3. Oxygen concentration	Increased systemically	Increased locally
4. Cost	450,000/week	42,000 INR/week
5. Level of evidence	Level 1b	Level II
6. Disadvantages	High cost Nonavailability of HBO2 chambers Systemic adverse effects like fatigue, damage to lungs and sinus, middle ear rupture, seizures	None

In view of the effectiveness of the topical oxygen therapy and with the cost factors of the devices available, we have started a novel way of performing topical oxygen therapy.

The novel method of applying the topical oxygen therapy uses the same principle of the standard devices for applying topical oxygen. Oxygen is infused at the rate of 10 l/min with a pressure of 30 mbars as compared to 10 l/min and 30–50 mb of the standard devices (Table 2). The cost of one cycle of the therapy is less than 500 INR. This method was tried in 3 patients (2 patients of necrotizing soft tissue infection and 1 patient of trauma). All had improved wound healing in terms of less session of debridement, earlier granulation tissue, and decreased hospital stay. This novel technique of applying topical oxygen is suitable for patients of low socioeconomic strata, and the ease with which it can be applied makes it a favorable alternative for standard devices.

Conclusion

Topical oxygen therapy is the recent modality for improved wound healing. The novel method of applying topical oxygen devised by us is effective, feasible, and cost-effective as compared to standard devices. There is a paucity of research in area of topical oxygen therapy applying modalities. Therefore, a randomized controlled trial is needed to validate this novel modality of applying topical oxygen therapy.

Table 2 Comparison of standard topical oxygen delivery devices with newly designed technique of applying topical oxygen

	Standard device	New technique
Pressure	30–50 mb	30 mbars
Oxygen flow	10 l/min	10 l/min
Cost/cycle	8600 INR	300 INR
Cycle duration	90 min	90 min

Conflict of Interest Authors declares that there is no conflict of interest.

References

1. Kessler L, Bilbault P, Ortéga F, Grasso C, Passemard R, Stephan D, Pinget M, Schneider F (2003) Hyperbaric oxygenation accelerates the healing rate of nonischemic chronic diabetic foot ulcers: a prospective randomized study. *Diabetes Care* 26(8):2378–2382
2. Fries RB, Wallace WA, Roy S, Kuppusamy P, Bergdall V, Gordillo GM, Melvin WS, Sen CK (2005) Dermal excisional wound healing in pigs following treatment with topically applied pure oxygen. *Mutat Res* 579:172–181
3. Blackman E, Moore C, Hyatt J, Railton R, Frye C (2010) Topical wound oxygen therapy in the treatment of severe diabetic foot ulcers: a prospective controlled study. *Ostomy Wound Manage* 56(6):24–31
4. Tawfick W, Sultan S (2009) Does topical wound oxygen (TWO2) offer an improved outcome over conventional compression dressings (CCD) in the management of refractory venous ulcers (RVU)? A parallel observational comparative study. *Eur J Vasc Endovasc Surg* 38: 125–132
5. Banks PG, Ho CH (2008) A novel topical oxygen treatment for chronic and difficult-to-heal wounds: case studies. *J Spinal Cord Med* 31(3): 297–301